GROWTH ON CUT-OVER AND VIRGIN WESTERN YELLOW PINE LANDS IN CENTRAL IDAHO[1]

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PURPOSE OF STUDY

The western yellow pine (*Pinus ponderosa*), because of the superiority of its lumber, its abundance, and its accessibility, is the most important commercial timber tree in the Boise, Payette, Weiser, Idaho, and Salmon National Forests in central Idaho. It is of the utmost importance, therefore, that the stands of this species be so managed as to insure an adequate stand of reproduction on cut-over lands and to maintain at its maximum the potential productivity of the type. In order to secure reliable information upon the establishment of a new forest, its growth and development, and to determine the basic principles governing silvicultural practice in this type, the Forest Service established a series of 16 permanent sample plots on the Payette National Forest in central Idaho in 1913 and 1914. The results obtained through the remeasurement of these plots in 1918 and 1919 brought out many points of interest concerning the management of western yellow pine stands in this region which are well worth attention.

GENERAL CONDITIONS ON THE PLOTS

Although these plots were established primarily to secure data on the growth of the reserved trees and natural reproduction in cut-over stands, unfortunately only three of them, plots Nos. 1–3, Table I, had been cut over when the logging operation was suspended in 1914. Nevertheless, they now afford a good comparison between the increment in cut-over and in virgin stands, showing behavior of advance reproduction in the latter. The cutting on these plots approached the method of clear cutting with scattered seed trees, although plot No. 1 had quite a number of trees left because they were too young. The uncut plots Nos. 4 to 16 give a good indication of the increment and mortality which may be expected in virgin stands. Furthermore, they afford interesting comparisons among three important sites common to the Intermountain region.

The sample plots were laid out in representative virgin stands under a variety of topographic and soil conditions.

The soil is a sandy to gravelly loam of granitic origin and is open, porous, and very gravelly on the south aspect. In the basins and on the north aspect the soil is less gravelly and more loamy because of a greater admixture of organic matter.

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TABLE I.—*Number of living and dead trees, 4 inches diameter breast high and over, to the acre*

Plot No.	Aspect	Species	Number of trees at first measurement	Increase or decrease (−) in number of trees	New trees entered	Number of dead trees	Volume of dead trees.[a]	
							Cu. ft.	*Per cent*
1	South	Western yellow pine	28.0	4.2	4.6	0.4	7.7	0.82
2	North	do	6.0	2.4	2.6	.2	11.0	4.66
3	Basin	do	7.8	6.0	6.0	.0	.0	.0
		Average (plots Nos. 1 to 3), cut-over.	13.9	4.2	4.4	.2	6.2	1.16
4	South	Western yellow pine	29.0	1.4	2.0	.6	122.9	2.74
		Douglas fir	3.6	.2	.2	.0	.0	.00
		Total	32.6	1.6	2.2	.6	122.9	2.31
5	do	Western yellow pine	36.6	5.2	6.0	.8	110.6	2.57
		Douglas fir	3.6	.0	.0	.0	.0	.00
		Total	40.2	5.2	6.0	.8	110.6	2.33
6	do	Western yellow pine	21.0	3.2	3.6	.4	94.8	2.86
		Douglas fir	2.6	−.2	.0	.2	10.8	5.76
		Total	23.6	3.0	3.6	.6	105.6	3.01
7	do	Western yellow pine	32.6	1.6	3.0	1.4	198.2	7.93
		Douglas fir	.8	.0	.0	.0	.0	.00
		Total	33.4	1.6	3.0	1.4	198.2	7.31
		Average (plots Nos. 4 to 7), virgin.	32.4	2.8	3.7	.9	134.3	3.30
8	Basin	Western yellow pine	27.4	1.2	1.4	.2	57.0	1.43
		Douglas fir	11.0	−.4	.0	.4	99.8	7.76
		Total	38.4	.8	1.4	.6	156.8	2.98
9	do	Western yellow pine	21.6	5.4	6.0	.6	78.8	2.81
		Douglas fir	19.4	−.4	.4	.8	26.7	1.45
		Total	41.0	5.0	6.4	1.4	105.5	2.27
10	do	Western yellow pine	26.4	−1.8	.2	2.0	64.6	1.90
		Douglas fir	27.0	.4	.4	.0	.0	.00
		Total	53.4	−1.4	.6	2.0	64.6	1.25
11	do	Western yellow pine	16.0	−1.6	.8	2.4	238.9	8.71
		Douglas fir	43.4	.2	.4	.2	7.8	.20
		Total	59.4	−1.4	1.2	2.6	246.7	3.73
		Average (plots Nos. 8 to 11), virgin.	48.0	.8	2.4	1.6	143.4	2.64
12	North	Western yellow pine	16.0	−.4	.2	.6	326.8	12.88
		Douglas fir	38.0	−2.0	.4	2.4	148.4	6.20
		Total	54.0	−2.4	.6	3.0	475.2	9.63
13	do	Western yellow pine	15.8	3.8	4.6	.8	70.4	3.69
		Douglas fir	109.4	4.8	9.2	4.4	36.4	.90
		Total	125.2	8.6	13.8	5.2	106.8	1.80
14	do	Western yellow pine	22.8	−.4	.6	1.0	70.2	2.44
		Douglas fir	30.6	2.8	3.8	1.0	47.3	4.24
		Total	53.4	2.4	4.4	2.0	117.5	2.94
15	do	Western yellow pine	6.2	1.8	1.8	.0	.0	.00
		Douglas fir	57.2	4.2	5.8	1.6	63.3	2.36
		Total	63.4	6.0	7.6	1.6	63.3	1.71
		Average (plots 12 to 15), virgin.	74.0	3.6	6.6	3.0	190.7	4.11
16	do	Western yellow pine	24.2	2.9	3.6	.7	81.5	3.19
		Average (plots Nos. 4 to 16),[b] virgin:						
		Western yellow pine	23.0	1.9	2.8	.9	110.0	3.82
		Douglas fir	21.7	.6	1.3	.7	27.5	2.13
		Total	44.7	2.5	4.1	1.6	137.5	3.30

[a] This includes only those trees which died since the plots were established.
[b] Averages weighted by plot areas for total area of 80 acres.

Like the bulk of virgin western yellow pine forests, the uncut stands are made up mostly of mature or overmature even-aged groups. Some immature groups have, however, become established in the openings in the forest cover caused by the death of old trees. Each of the plots is 5 acres in extent, with the exception of plot No. 16, which covers 20 acres. Plots Nos. 4 to 15 are located on Big Pine Creek, at an altitude of 4,000 to 4,500 feet. Plots Nos. 1 to 3 are on Carpentier Creek, at an elevation of approximately 3,700 feet, while plot No. 16 is located on Poorman Creek, at about the same altitude as plots Nos. 1 to 3. All of these plots are in pure stands of western yellow pine. Of the uncut plots, Nos. 4, 5, 6, and 7 are on ridge tops and south aspects where western yellow pine occurs in practically pure stands. Plots Nos. 8, 9, 10, and 11 are in basins and coves where both species are found in mixture, but with western yellow pine still in the ascendency, while plots Nos. 12, 13, 14, and 15 are located on north aspects, with Douglas fir (*Pseudotsuga taxifolia*) predominating, but with an admixture of yellow pine.

The conditions in the cut and uncut plots as to vigor, mortality, and growth during the five-year period will be brought out in summarizing the results of remeasurement.

INCREASE IN NUMBER OF TREES

The stocking on the cut-over plots is conspicuously incomplete, while the characteristic occurrence of western yellow pine in groups gives an appearance of still greater inadequacy. There are indeed many small saplings on the ground, established before the cutting took place, but these have not yet had time to grow into the 4-inch class, and so did not appear in the records used in this study. The cut-over plots show a somewhat greater increase in number of trees than the virgin plots; an average increase of 4.2 trees an acre during the five-year period as compared with an average increase of 2.5 trees on the uncut plots (see Table I). This difference will in all probability become more pronounced in the course of the next decade or two. It can reasonably be expected that there will be comparatively little loss due to disease and overmaturity in cut-over areas if all defective trees and those of poor vigor be removed at the time of cutting.

INCREASE IN VOLUME

Table II is a summarized statement of the increment on the sample plots during the five-year period. In order to show the actual amount of new wood added each year by growth, the gross increment is also given. Since loss of volume through death of trees can not be avoided under present economic conditions, which render impracticable a return in less than 40 years and possibly longer, it is plain that the figures on net growth, indicating the actual gain or loss in volume, are at present the more significant. It is important to note that without cutting, many of the causes of loss in these overmature stands can not be eliminated.

The table following reveals a wide range in the net increments on the various plots. Other things being equal, the growth on basin plots Nos. 8 to 11 should have been the highest of all, but because of a large number of young thrifty trees (especially Douglas fir) on the northern aspects the growth is actually greater on plots Nos. 13 to 15. The low increment on plot No. 12 is due largely to the high percentage of insect-infested trees. The next lowest rate of net growth per cent is on plot No. 11, where *Dendroctonus* bark-beetle infestation also is serious. Mistletoe, which is prevalent on plot No. 9, does not appear to retard the growth of Douglas fir so much as do bark beetles. Net losses are shown for only three of the uncut plots (plots Nos. 10, 11, 12), though the western yellow pine shows a net loss on five plots in all and Douglas fir on two.

TABLE II.—*Increment per acre of trees 4 inches diameter breast high and over*

Plot No.	Aspect	Species	Volume per acre at first measurement[a]		Periodic annual increment per acre[b]			Percentage of periodic annual cubic foot increment	
					Gross	Net		Gross	Net
			Cu. ft.	*Board ft.*	*Cu. ft.*	*Cu. ft.*	*Bd. ft.*		
1	South	Western yellow pine	942.0	4,780	46.8	45.3	285	5.0	4.8
2	North	do	235.9	1,228	15.0	12.8	75	6.4	5.4
3	Basin	do	424.6	2,352	26.6	26.6	164	6.3	6.3
		Average, plots 1 to 3, cut over.	534.2	2,787	29.5	28.2	175	5.5	5.3
4	South	Western yellow pine	4,483.1	28,584	32.1	7.5	54	.7	.2
		Douglas fir	839.6	4,410	10.7	10.7	63	1.3	1.3
		Total	5,322.7	32,994	42.8	18.2	117	.8	.3
5	do	Western yellow pine	4,306.8	27,212	46.2	24.1	161	1.1	.6
		Douglas fir	437.0	1,902	5.7	5.7	31	1.3	1.3
		Total	4,743.8	29,114	51.9	29.8	192	1.1	.6
6	do	Western yellow pine	3,316.1	21,752	27.0	8.0	37	.8	.2
		Douglas fir	187.5	782	3.8	1.6	9	2.0	.9
		Total	3,503.6	22,534	30.8	9.6	46	.9	.3
7	do	Western yellow pine	2,499.3	14,992	38.2	−1.4	0	1.5	−.1
		Douglas fir	212.8	1,010	2.5	2.5	12	1.2	1.2
		Total	2,712.1	16,002	40.7	1.1	12	1.5	.04
		Average, plots 4 to 7, virgin stands, south aspect.	4,070.6	25,161	41.6	14.7	92	1.0	.4
8	Basin	Western yellow pine	3,978.6	25,454	25.2	10.9	82	.6	.3
		Douglas fir	1,285.6	5,626	18.8	−6.1	−25	1.5	−.5
		Total	5,264.2	31,080	44.0	4.8	57	.8	.1
9	do	Western yellow pine	2,805.5	18,032	17.9	−1.8	−25	.6	−.1
		Douglas fir	1,838.1	8,040	26.7	20.0	96	1.5	1.1
		Total	4,643.6	26,072	44.6	18.2	71	1.0	.4
10	do	Western yellow pine	3,400.7	21,830	19.3	6.4	68	.6	.2
		Douglas fir	1,757.0	7,008	34.4	34.4	164	2.0	2.0
		Total	5,157.7	28,838	53.7	40.8	232	1.0	.8
11	do	Western yellow pine	2,741.4	18,044	9.0	−50.7	−308	.3	−1.8
		Douglas fir	3,880.1	17,034	43.2	41.2	180	1.1	1.1
		Total	6,621.5	35,078	52.2	−9.5	−128	.8	−.1
		Average, plots 8 to 11, virgin stands, basin.	5,421.8	30,267	48.6	13.6	58	.9	.3
12	North	Western yellow pine	2,537.4	16,640	15.5	−66.2	−476	.6	−2.6
		Douglas fir	2,395.0	9,540	17.9	−19.2	−70	.7	−.8
		Total	4,932.4	26,180	33.4	−85.4	−546	.7	−1.7
13	do	Western yellow pine	1,909.4	12,298	12.3	−1.8	−6	.6	−.1
		Douglas fir	4,033.3	15,560	74.9	67.6	270	1.9	1.7
		Total	5,942.7	27,858	87.2	65.8	264	1.5	1.1
14	do	Western yellow pine	2,877.4	19,754	43.7	29.7	170	1.5	1.0
		Douglas fir	1,114.6	4,070	23.0	13.5	52	2.1	1.2
		Total	3,992.0	23,824	66.7	43.2	222	1.7	1.1
15	do	Western yellow pine	1,017.3	6,578	14.4	14.4	102	1.4	1.4
		Douglas fir	2,684.2	10,350	52.0	39.3	156	1.9	1.5
		Total	3,701.5	16,928	66.4	53.7	258	1.8	1.5
		Average, plots 12 to 15, virgin stands, north aspect.	4,642.2	23,698	63.4	19.3	50	1.4	.4
16	do	Western yellow pine	2,556.2	15,964	68.3	52.0	355	2.7	2.0
		Average, plots 4 to 16, virgin stands:[c]							
		Western yellow pine	2,881.1	18,439	35.9	11.7	80	1.2	.4
		Douglas fir	1,291.6	5,333	19.6	13.2	59	1.5	1.0
		Total	4,172.7	23,772	55.5	24.9	139	1.3	.6

[a] Cubic volume includes the solid contents of the entire stem, including the stump, of all trees 4 inches and over at breast height. Board foot volume includes all trees 12 inches and over at breast height, volumes read from a Scribner decimal C volume table for the Payette Forest.

[b] Plots Nos. 1 to 7, inclusive, Nos. 10, and 13 to 16, inclusive, show increment for a 5-year period, while plots Nos. 8, 9, 11, and 12 show it for a 4-year period.

[c] Averages are weighted by plot areas for total area of 80 acres.

A striking difference exists between the rate of growth in the cut-over and the uncut stands. The cubic volume of the cut-over stands has increased at the rate of 5.3 per cent per annum since the plots were established, while the virgin stands show an annual increase of only 0.6 per cent for the same period. With an indicated annual increment of 24.9 cubic feet per acre it is apparent that the loss—by windfall, bark beetles, mistletoe, or otherwise—of one large tree containing 249 cubic feet would completely offset 10 years' growth on 1 acre of virgin timber.

The actual average loss was found to be 6.2 cubic feet an acre for the five-year period in the cut-over stands and 137.5 cubic feet an acre in the virgin stands during the same time. This comparison is gratifying, although the situation still demands improvement of silvicultural practice. It is evident that through a careful selection of trees to be left standing on cut-over areas the maintenance of a desirable rate of volume growth will be made possible.

The percentage of trees showing lack of vigor, as emphasized by Table III, is a good criterion of the general condition of the stands. In this study slight injuries were not considered; the tree had to be decidedly lacking in vigor before being so classified. For example, Douglas fir which showed light mistletoe infection or western yellow pine with slight porcupine injury, if otherwise thrifty, were still classified as vigorous. Since a general lack of vigor and thrift usually precedes death, this will be treated along with mortality.

TABLE III.—*Defective trees on sample plots in 1918 and 1919, with summary of important causes of lack of vigor, in percentages of total living trees and cubic volume at beginning of period*

Cause of lack of vigor	Cut-over plots Nos. 1 to 3		Virgin plots Nos. 4 to 16					
	Western yellow pine		Western yellow pine		Douglas fir		Total	
	Trees	Cubic volume	Trees	Cubic volume	Trees	Cubic volume	Trees	Cubic volume
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Mistletoe infection					3.37	4.66	1.59	1.47
Suppression	2.94	0.57	1.65	0.11	2.35	.16	2.01	.13
Porcupine injury			.65	.14			.34	.10
Defective tops [a]	.37	.01	2.81	3.96	.90	1.24	1.91	3.07
Unclassified			1.70	1.10	1.80	2.37	1.75	1.44
Total, all causes	3.31	.58	6.81	5.31	8.42	8.43	7.60	6.21

[a] This group includes such conditions as tops broken in logging, spike tops, and stag-headed trees.

CAUSES OF LOSS

Table IV is a record of mortality from different causes. Of the agents listed as responsible for the death of the trees, the most important are bark beetles, windfall, and mistletoe. In many cases large mature and overmature trees were killed, resulting in a large volume loss.

TABLE IV.—*Causes of death of trees 4 inches diameter breast high, and over, in percentages of total living trees and cubic volume at the beginning of period* [a]

Cause of death	Cut-over plots Nos. 1 to 3		Virgin plots Nos. 4 to 16					
	Western yellow pine		Western yellow pine		Douglas fir		Total	
	Trees	Cubic volume	Trees	Cubic volume	Trees	Cubic volume	Trees	Cubic volume
	Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Windfall			0.44	2.65	0.75	0.63	0.59	0.65
Insects			2.49	2.85	.46	.97	1.50	2.27
Mistletoe					.29	.27	.14	.08
Suppression			.39	.01	.35	.02	.37	.02
Logging	0.48	0.09						
Porcupines			.11	.001			.06	.002
Unclassified	.96	1.07	.33	.29	1.33	.24	.82	.28
Total	1.44	1.16	3.76	3.811	3.18	2.13	3.48	3.302

[a] This includes only those trees which died since the plots were established.

A maximum loss of 12.87 per cent in the five-year period was found on one uncut plot. Although this loss was occasioned by the death of three large overmature trees, it is nevertheless alarming. Table IV shows that insect attacks, particularly those of the western pine beetle (*Dendroctonus brevicomis*), are responsible for a volume loss over twice as great as that caused by all other agents, and that this has been confined to the virgin stands and to the killing of individuals or small groups of trees. Under normal conditions the infestations are often sporadic, threatening for a year or two, and then decreasing. However, while no serious epidemics have occurred in recent years in this locality, it must not be forgotten that this insect is very destructive to western yellow pine throughout the West and constitutes a real menace which, from time to time, assumes very serious proportions, possibly aggravated by the advent of favorable climatic conditions. Practically all the insect injury noted occurred in trees above the sapling stage, and sufficient insect activity has been shown in virgin stands to warrant foresters giving it careful attention.

On these plots windfall was confined to the mature and overmature trees in the larger diameter classes. On the national forest timber sales this is being partially controlled through the selection of wind-firm individuals for seed trees and through the removal of very tall trees on exposed situations after adjoining trees which protect them are cut. As a matter of fact, wind-throw here was not nearly as serious as it appears to have been in the Whitman National Forest in eastern Oregon (*11*).[2] It is gratifying to note that no wind-throw occurred on the cut-over plots. Since a large proportion of the windfall occurs within four or five years after cutting and the remainder in rapidly decreasing amounts, the exercise of reasonable precaution in marking will undoubtedly eliminate the danger of heavy loss.

Western yellow pine in the vicinity of these sample plots is not infected with mistletoe (*Razoumofskya campylopoda*), although on the basaltic soils of the western division of the Payette National Forest and the nearby Weiser National Forest heavy infections occur. There is a suggestion here of an interesting causal relation between soil type and the local distribution of mistletoe, although the significance and constancy have not been determined. Douglas fir is frequently infected with mistletoe (*Razoumofskya douglasii*). Indeed, on plot No. 8

[2] Reference is made by number (italic) to "Literature cited," p. 1148.

this infection assumed rather serious proportions, causing a loss of 3.09 per cent of the volume. While the loss due to mistletoe is not alarmingly high on any of the plots, the indications are that the death rate will increase from year to year. The information at hand indicates that the cutting of infected trees is the most practical method of control (*6*). Every effort should therefore be made to remove moderately and heavily infected trees when cuttings are made.

Death from suppression obviously results in a relatively small volume loss, although the number of dead trees may be large. The habitual occurrence of western yellow pine in fairly open stands which would seem to predicate a small amount of suppression is, to some extent, counterbalanced by the tendency to form scattered groups, with resultant heavy losses in the smaller diameter classes. The later records on these plots will supply valuable information as to the relative light requirements of the two species, their resistance to overtopping and, on the cut-over plots, their ability to recover upon being released.

It is noteworthy that on the cut-over plots all of the general lack of vigor and thrift is either the result of suppression which took place before the cutting and from which the western yellow pine had not recovered, or is due to the loss of a considerable part of the crown through careless felling of adjacent trees during logging. It would appear that for trees showing a lack of vigor on plots Nos. 1 to 3 inclusive, 3.31 is too high a percentage for recent cuttings, even though the trees comprise only 0.58 per cent of the total cubic volume on the cut-over area. (See Table III.) The need for greater care in logging to reduce the injury to reserved trees and to utilize all suppressed trees which are merchantable can scarcely be overemphasized. The plots show a significantly high percentage of trees in the mature and overmature virgin stands lacking in vigor and consisting of injured, defective, and decadent trees.

Porcupines have caused some injury in certain localities. The actual volume loss due to this agent is small. Saplings are frequently killed by girdling, but large trees are rarely killed. However, the leaders are often girdled, which sets the tree back from 5 to 15 feet or even more in height. New leaders are usually developed, but constrictions and pronounced crooks remain as evidence of the attack, which may even appreciably affect the amount and grade of lumber sawed from trees which recover.

NATURAL REPRODUCTION

One of the main objects of silvicultural management is to secure prompt restocking after cutting. In fact, a forest in which restocking does not follow cutting is doomed ultimately to annihilation. In the forests of the Intermountain region, where artificial regeneration is subject to numerous adversities and an almost prohibitive cost (*7*), natural reproduction is of the utmost importance. Natural reproduction in the western yellow pine type, therefore, has been one of the foremost subjects of investigation in central Idaho. The more important results of these studies have already been published and therefore in the following paragraphs only the principal results will be summarized.

The effect of sheep grazing upon coniferous reproduction and the extent to which this damage can be reduced by more careful use of the range was made the subject of an intensive study by Sparhawk (*10*).. Detailed information on germination, survival and causes of death of seedlings with particular reference to grazing injury was secured on 151 small sample plots in the Payette National Forest. This study emphasized the general principle that the extensive browsing of coniferous reproduction and the less palatable forage species is the best evidence that the range is being overgrazed. In many instances on cut-over areas in the course of regeneration it may be desirable to reduce materially or even to eliminate grazing, particularly that of sheep.

Adverse climatic conditions, while still important influential factors, do not so completely dominate the reproduction problem in central Idaho as they do in the Southwest (*9*). Yet it is considered desirable to retain a sufficient number of trees to preserve forest conditions, in addition to insuring an adequate seed supply, since a heavy opening of the stand increases the danger from wind, excessive evaporation, deficient moisture, and frost injury (*3*, *4*, *5*).

As the result of special studies (*5*) failure of reproduction was found to be due more to high mortality the first three years following germination than to a lack of germination. By far the greatest mortality was found in seedlings less than a year old. Very few over 6 inches high die in any one year. A leaf disease, caused by *Phacidium infestans*, has caused a significant loss among seedlings and saplings of the fairly tolerant Douglas fir and promises to continue as a cause of mortality on the plots. Another leaf fungus (*Hypoderma deformans*) was frequently found to be the cause of fairly heavy losses of western yellow pine seedlings and saplings and ranks along with suppression as a cause of mortality in this species on northern aspects and in basins, especially where the cover is rather dense.

The same field studies showed that the most serious causes of death, aside from the two diseases just mentioned, are in the order of their importance: Drought, browsing and trampling by grazing animals, especially sheep, girdling by rodents, winter-killing, including excessively low temperatures, frost injury, and rodents or birds which bite off the newly germinated seedlings. Seedlings and saplings 15 to 20 years old were occasionally found girdled by rodents. Balanced against this is the fact that rodents render considerable aid in disseminating and burying the seed, thereby promoting favorable conditions for satisfactory germination.

One of the most noteworthy results of these studies has been to emphasize the great importance of advance reproduction. The establishment of advance growth is a long slow process, doubtless requiring as much as 20 years or even more to secure adequate restocking on the poorer sites. Moderately heavy cuttings appear to be fully justified provided advance growth is reasonably abundant and provided healthy, vigorous seed trees are left as insurance against loss of the advance reproduction by fire. It is also evident that efforts to deliberately change the composition of the stand by the method of cutting will produce few tangible results. Western yellow pine is holding its own on potential yellow pine sites and it can be succeeded by Douglas fir only in the tension zone between the two types or in the Douglas fir type. A large number of Douglas fir seedlings can be found, but owing to a heavier mortality extending over a longer period of years, fewer seedlings actually become established than in the case of western yellow pine. Where the two species occur in mixture, as in the basins, the pine in the juvenile stage grows faster than Douglas fir. However, these different rates of juvenile growth do not continue beyond about 40 years of age when Douglas fir surpasses the pine in diameter growth at least.

APPLICATION OF RESULTS IN SILVICULTURAL PRACTICE

When the national forests of the West were placed under Government administration, little exact information on the characteristics and requirements of the important native forest trees was available upon which to base rules for silvicultural practice. As a result of repeated fires, grazing, and insect infestations, the forests were generally understocked and often had a preponderance of overmature and decadent timber and a deficiency of trees of the intermediate age classes from which to select vigorous, thrifty seed trees. All too often advance reproduction was poorly distributed or lacking. In addition there was no sale for defective timber.

Economic conditions have improved to some extent, but still only one cut will be possible for a long time. The marking rules must frequently be based on a compromise between economic necessity in logging practice and the best silvicultural practice.

The distribution of the reserved trees over the area is a matter of great importance. Except for the danger of wind-throw on exposed ridges, it is inadvisable to leave groups of trees of any considerable area untouched, since such blocks are inimical to both acceleration of growth and even distribution of new reproduction. Leaving trees in groups neutralizes the advantageous effects of cutting, and on the better sites may interfere with western yellow pine reproduction. Great care should be exercised in selecting trees for increased volume growth and enhanced quality of the subsequent cut. These conclusions have been substantiated by Dunning's studies (*1*, *2*) in California. He has also clearly pointed out that the crown furnishes the most reliable criterion of what may be expected from reserved trees. A dense, bright-green, pointed crown is indicative of a thrifty tree. Trees with long narrow crowns are generally growing more rapidly than average trees of the same size. As a general principle, it is undesirable to leave mature or overmature seed trees because even on the best sites the death of one large tree will greatly reduce the net increment and the loss will be material of the highest quality. Furthermore, satisfactory growth can not be expected from trees of either western yellow pine or Douglas fir over 30 inches in diameter, even on the best sites in this region.

The marking practice in effect in the central Idaho forests is, in many respects, quite similar to that outlined by Munger (*8*) under the selection system or a modified form of it for the management of the western yellow pine type in eastern Oregon. The present marking practice in central Idaho provides for reserving a considerable nucleus of vigorous immature standards and a sufficient number of sound, thrifty mature trees to make up the necessary quota. These may be desired for the purpose of maintaining the continuity of the forest cover, for increased volume and value increment in a second cut, or to insure adequate seed for regenerating the stand. All defective, diseased, and suppressed trees should be marked for cutting unless needed as fire insurance or seed trees. No defective or diseased tree should be left standing if it is evident that it will not live until the next cutting, unless it is absolutely needed for silvicultural purposes. When it becomes necessary to reserve trees among the larger diameter classes, vigorous, thrifty trees of good form and development should be selected. It is thus evident that the marking on each individual area must be varied to meet the silvicultural requirements of the forest. The importance of careful, intelligent marking of timber on cutting areas can not be overemphasized, since this is the means by which rational silvicultural management is actually secured in practice.

SUMMARY

This report presents the first important results of a growth study which is still incomplete. Permanent sample plots are used to compare cut-over and virgin forests as to condition of stands, mortality, and increment. The cut-over areas are in a much thriftier and more vigorous condition. In the virgin stands the loss of vigor is caused principally by bark-beetle infestations, mistletoe infection of Douglas fir, wind-throw, and suppression. These causes of loss were largely eliminated from the cut-over stands. Porcupines are responsible for a relatively small amount of injury.

The average rate of net volume growth in relation to the volume of the stand is strikingly greater in the cut-over than in the virgin stands. In the latter, the annual loss through death and decay practically nullifies the annual growth.

Great care should be taken in silvicultural markings to reserve, as seed trees, only thrifty individuals which can reasonably be expected to survive until the next cut is made and to continue to grow at a profitable rate. Every precaution should be taken to avoid injury to advance growth at the time of logging because of its supreme importance in regenerating the uneven-aged forests of western yellow pine promptly.

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PLATE 1

A.—Cut-over stand of western yellow pine on a south-facing slope. The presence of saplings and small-sized trees gives the appearance of a "selection" cutting. The opening and the absence of a ground cover of shrubs is typical of ridges. Payette National Forest (plot 1).

B.—Heavy cutting on a north-facing slope. After six years reproduction is still deficient on this area (plot 2), a condition evidently due to the inability of the small-sized trees left after cutting to supply sufficient seed.


A


B


A


B

PLATE 2

A.—The advance reproduction is deficient in this virgin stand of western yellow pine on a south-facing slope of moderate steepness. Ground cover is not dense on such sites and the lack of advance reproduction emphasizes the need for care in marking such stands, if prompt restocking is to be assured. Payette National Forest (plot 5).

B.—A steep south slope necessitates light cutting as in the case of this mature stand of western yellow pine on a steep south slope (plot 6). On such situations, particularly near the tops of the ridges, cutting should be light to avoid heavy wind-throw and excessive drying of the soil. Payette National Forest.

PLATE 3

A.—Large, thrifty trees must be reserved to reseed such areas. A mature stand of western yellow pine and Douglas fir typical of the basins in the Payette National Forest. Advance reproduction is deficient on this area (plot 8), except in the openings. When such stands are cut over, satisfactory restocking must depend upon reseeding by vigorous trees of large diameter left for that purpose.

B.—Abundant advance reproduction under a mature stand. Unusual care should be exercised in cutting such stands as this one of western yellow pine and Douglas fir to release and preserve the abundant young growth, particularly of yellow pine. Payette National Forest.


A


B